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ABSTRACT

To compare the unit cost of computer-assisted instruction (CAI) programs, there must be a standard model for calculating the cost of computer services. Such cost can be classified into direct costs--expenditures made directly by the group in charge of CAI programs, and indirect costs--expenditures made by other groups in support of CAI services. This paper lists possible categories of direct and indirect costs and provides formulas for calculating cost distributions. (EMH)

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# GENERAL PURPOSE COST DISTRIBUTION MODEL

# FOR

# COMPUTER ASSISTED INSTRUCTION

by

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## NECESSITY of a COST DISTRIBUTION MODEL

Since the advent of commercially available Computer Assisted Instruction systems, there has been many a battle fought over the cost of CAI. If one reviews some of the various publications devoted to computing and/or instructional computing, many different claims have been lodged as to the true cost of CAI. In the past year alone, there have been claims that CAI costs from as little as $ .10 per student hour to as much as $ 11.00 per student hour. The problem with these "costs" is that there is no evidence of any model that was used to arrive at such costs. Furtheremore, if there is a model behind the cost acclaims it is never explained or detailed.

Inordinately, those who are still beating their breasts(heads) to prove CAI ineffective usually prove that CAI is effective(to their dismay) but the cost is prohibitive; however, on the other hand, the advocates of CAI are just as guilty for they tend to claim costs that are literally too low. Unfortunately, it is not just the optimistic or pessimistic educator that is to blame, but also the computing center can be notorious for gouging the instructional computing applications.

Historically, it seems almost a law of Darwinian Evolution, adminstrative computing budgets are nominally far less than instructional computing. This situation often leaves the computing center hard put to provide good support for all the differing applications that must be supported. Thus, in order to compensate for lacking support monies, instructional users often find themseleves paying far more than they really should be paying. The resultant situation is the academicians ignoring the cost items on the computer center support side of the instructional application combined with the computing center's need for additional funds. This strange scene often leaves many frustrated and few satisfied. This scene could be avoided if both sides were to analyse the costs involved and look at the whole scope rather than each looking in his own little corner of reality.

To this point, we have been looking at a symptom of a problem not the cause of the problem. The problem is the definition of who spends what in direct and indirect support of what. In this case, one what will be CAI rather than some other type of computing application. Ideally, it would seem that defining such expenditures represents no particular problem. That may be true if one has already done the necessary task analysis to determine the actual expenditures. However, if such analysis has not been done, the problem is obvious. The only way that such can be resolved is the development of a model that will reflect all costs involved in the support of CAI by those groups that have such responsibility.

## DEFINITION and DEVELOPMENT of a COST DISTRIBUTION MODEL

The development of a model may seem a simple task; however, it is by no means that simple. Before a model or even the costs identified, there must be agreement as to the types of expenditures. The most direct method of identifying the expenditures is to classify them as direct costs and indirect costs. .

Having defined the types of cost classification, it is then possible to define the actual classifications:

direct cost - cost expenditures made directly by the department or group that is in charge of CAI.

indirect costs - cost exepnditures made by another department in support of providing CAI. (computer center)

Now that actual classifications and definitions have been set forth, it is then possible to begin the necessary task analysis that will bring about the end goal of a fair share cost distribution.

The completion of the task analysis will yield many different costs that are involved with CAI. Some of these costs will not be shared by all users involved with CAI, but the majority of the costs will be applicable to all users regardless of vendor or software used to provide CAI. Thus, the most common cost categories for CAI can be stated:

1) hardware - rental/purchase
2) hardware maintanence
3) software - rental/purchase
4) CAI curriculum - rental/purchase
5) CAI curriculum - development/implementation
6) Disk space - used/required
7) core storage used
8) computer processing time
9) paper, cards, paper tape
10) ancilliary support - operator
11) ancilliary software
12) dedicated support personnel
13) leased lines
14) dial - up lines
15) modems
16) telecommunications controller - TCU

With the identification of the most common costs of CAI, it is then possible to place these costs either under direct or indirect cost areas.

direct costs

1) hardware - rental/purchase
2) software - rental/purchase
3) CAI curriculum - rental/purchase
4) CAI curriculum - development/implementation
5) disk space used
6) core storage used
7) processing time used
8) paper, cards, paper tape used
9) ancilliary software used
10) support personnel - dedicated/occasional
11) cost of modems
12) cost of leased lines
13) cost of dial-up lines

Itemization of those costs that are most likely to be direct costs leads to indirect costs.

indirect costs

1) hardware - rental/purchase
2) memory used
3) processing time used
4) percentage of computing system dedicated to CAI
5) ancilliary support personnel
6) ancilliary software
7) cost of TCU equipement

At this point, we have now narrowed the area of concern from just the concept of cost to the concepts of direct and indirect costs. It should be evident that the indirect costs must be passed on to the group that is providing CAI. Further, it should be evident that the CAI group must be able to distribute the cost across the users of the CAI system. Thus, the final task is to develop expressions that represent the various cost categories. This expression when filled in and combined will yield the true cost of CAI for any given installation. Refer to Appendix I for the actual mathematical expressions; refer to Appendix II for sample costs derived through the use of the model.

With the development of the mathematical expressions, it is then possible to begin calculating the cost of CAI per individual student hour. This cost can be represented per individual student CAI lesson, by group of students using a specific CAI lesson, per all students using the CAI system. The only charge left to us is the determination of the constants that are used for the representation and calculation of the cost. The most common constants that must be known are:

1) hours CAI availability - day, month, year
2) overall cost of computing system - year
3) hours computing system used - year
4) hardware rental - month, year
5) software rental - month, year
6) disk used per individual CAI module
7) disk used per student using a given CAI module(s)
8) processing time used per hour of student use on CAI
9) processing time used per month for CAI
10) hours CAI used per month
11) hours CAI idle per month
12) average amount of paper used per student for a given CAI module
13) cost per unit measure of disk storage
14) cost per second of processing time
15) cost per sheet of paper
16) number of terminals used for CAI
17) CAI curriculum rental - month, year
18) CAI curriculum development/implementation - month, year
19) CAI curriculum purchase (averaged over 12 month period)
20) hours spent on CAI curriculum development/implementation
21) number of students using given CAI module
22) total number students using CAI system
23) number hours student spent on given CAI module
24) total number hours spent on CAI modules by total number using CAI

25) processing time, paper required, disk used for reporting student performance and progress histories.
26) number of performance and progress histories run
27) cost of percentage of computing system dedicated to run CAI
28) salaries of dedicated and ancilliary support personnel
29) cost of leased lines
30) cost of dial - up lines
31) cost of modems
32) cost of TCU equipement
33) number of non-CAI users using same terminals or same TCU equipement
34) cost per port on TCU

Once all the knowns are identified and equated to a dollar amount, the only resultant task is the working of the appropriate expressions. It should be remembered that the model is general purpose and any charge that is not applicable can be ignored. Any charge that is unique to a particular installation can easily be added.

The use of a cost distribution model will allow for the fair accounting and distibution of the cost; for by use of such model the cost of CAI can be charged back to individual departments or even individual users. There can at least be the basis for even the cost effective aspects of CAI.

# APPENDIX I

## Cost Distribution Formulas

DIRECT COST FORMULAS

HC = hardware and software subcharge per terminal per hour

= (hardware rental or purchase per year + software rental or purchase per year) * (hours CAI available per year * number of terminals)

DKC = disk use subcharge per student per CAI module

= ((disk used per CAI module + disk required per student) * cost per unit of disk storage) * ((number student spaces available/number of active students)/number of students using CAI mod.)

CSC = core storage subcharge per hour per student

= (amount of core required for CAI * cost core per unit)/(hours CAI available per year * #term.)

PTC = processing time subcharge per hour per student

= (average processing time required per hour CAI * cost per unit of processing time)/ #term.

PC = paper subcharge per student

= (cost per sheet of paper * number of sheets of paper used per session) * number of sessions per student * number of students

CRP = CAI curriculum rental or purchase subcharge per hour per student

= ( cost of curriculum rental or purchase per year/(number hours CAI available per year*number of terminals))/number of students using CAI module

CIP = CAI curriculum development/implementation subcharge per hour per student

=(((hours development + hours implementation) * rate of pay per hour)/(number hours CAI available per year * number of terminals))/number of students using CAI module

ASC = ancilliary software charge per hour per student

=(cost of ancilliary software per year/(number of hours CAI available per year * number of term.)) / number students using CAI

DIRECT COST FORMULAS - continued

HRC = human resource subcharge per hour per student

= (salaries of support personnel/(number hours CAI available per year * number of terminals))/ number of students using CAI

RAC = response analysis subcharge per hour per student

= ((cost of processing time used + cost of paper used) * number of runs)/number of students using CAI module(s)

TMC = telecommunication modem subcharge per hour per student

= ( cost of modem per year / (number hours CAI available per year * number of terminals using modem))/number of students using terminal that requires modems

CLC = cost of leased lines subcharge per hour per student

= (cost of leased line per year/(number hours CAI available year * number of leased terminals))/ number of students using terminal requiring leased line

DLC = dial up line subcharge per hour per student

= (cost of dial-up line per year/(number hours CAI available per year * number of terminals))/ number of students using dial-up terminal

UAC = usage adjustment subcharge per hour per student

= (number hours CAI used / number hours CAI available)/ number of students using CAI

INDIRECT COST FORMULAS

ITCT = indirect total subcharge per terminal per hour - accounts for percentage of computing system dedicated to CAI, percentage of ancilliary hardware for CAI, processing time lost due to CAI

= (((percentage computing system devoted to CAI * cost of computing system) + (processing time used per hour CAI * cost of processing time per hour)/(number hours CAI available per year * number of terminals))/number of students using CAI

ITHC = indirect total subcharge per hour CAI - accounts for ancilliary software and support personnel

= ((cost of ancilliary software + (perecentage person dedicated to CAI support * person salary)) / number hours CAI available per year)/number of students using CAI

ITTC = indirect telecommunications subcharge per hour per terminal

= ((percentage of TCU used for CAI * cost of TCU per year)/(number of hours CAI available * number of terminals using TCU))/ number of students using terminal requiring TCU



TOTAL COST of CAI

DIRECT COST = ((HC + CSC + PTC + CRP + CIP + ASC + HRC + TMC + CLC + DLC) * number of hours student used CAI module(s)) + DKC + PC + RAC + UAC

(DC)

INDIRECT COST = (ITCT + ITHC + ITTC) * number hours student used CAI module(s)

(IC)

TC = Total Charge per student

= DC + IC

ATCS = average total charge per student

= TC/number of students

ATHS = average total charge per student per hour

= TC/ (number students * number hours)

# APPENDIX II

# REPRESENTATIVE COST DISTRIBUTIONS

CONSTANT INFORMATION

| | | |
|---|---|---|
| 0) | amount of core required for CAI | 104k |
| 1) | hours CAI scheduled per year | 2400 |
| 2) | total number of terminals | 9 |
| 3) | total number of students using CAI | 800 |
| 4) | average processing time used per month | 40 cpu/hrs |
| 5) | processing time per hour per terminal | 12 cpu/secs |
| 6) | PTC | $.24 |
| 7) | cost unit disk storage | $.01 track |
| 8) | HC | $.60 |
| 9) | ITCT | $2.30 |
| 10) | ITHC | $.01 |
| 11) | ITTC | $.00 |
| 12) | sheet 11 x 14 7/8 paper | $.03 |

RELATIVE INFORMATION

1) CAI module name: acct
2) disk used for module: 266 units
3) disk used per student: 2 units
4) pages of paper: 0
5) available student spaces: 111
6) used student spaces: 100
7) unused spaces: 11
8) development hours: 10
9) cost development per hour $9.50
10) given student id: 2
11) hours on CAI: 4
12) total hours spent by 100 students: 325

COST DISTRIBUTION

- individual student

| | | | |
|---|---|---|---|
| HC = $.60 | PC = 0 | HRC = $.02 | DLC = 0 |
| DKC = $.02 | CRP = 0 | RAC = 0 | UAC = $.34 |
| CSC = $.05 | CIP = $.01 | TMC = 0 | HC = $.60 |
| PTC = $.24 | ASC = 0 | CLC = 0 | |
| ITCT = $2.30 | ITHC = $.01 | ITTC = 0 | |

DC = ((.60 + .05 + .24 + 0 + .01 + 0 + .02 + 0 + 0 + 0)* 4) + .02 + 0 + 0 + .34

DC = $4.04

IC = $2.31

TC = 4.04 + 2.31 =$6.35
ATCS = $6.35
ATHS = 6.35/4 = $1.58

- information necessary to calculate for 100 students is given. I will leave this for your perusal.